[redacted]

 99 7104

August 24, 1965

Dear Dick:

I'm not sure if you are still our monitor on this contract but I have sent these to you anyway. Would you make sure that [redacted] gets a copy and ask Frank if [redacted] should get one. I'm sorry these are a little late but I forgot to bring them back on my last trip to Washington.

Sincerely,

Al

[redacted]

AH:lo
Encl: TM 723-1 (10 copies) [redacted]

Copy # 2 to [redacted]
3 to the 97104 file
4
5
6
7
8
9
10

Declass Review by NGA.

[redacted]

Copy # 1

THE JUDGMENT OF STEREOSCOPIC DEPTH IN PHOTOGRAPHS AS A FUNCTION OF CONVERGENCE AND OBLIQUITY ANGLES

Technical Memorandum 723-1

Prepared by

July 12, 1965

THE JUDGMENT OF STEREOSCOPIC DEPTH IN PHOTOGRAPHS AS A FUNCTION OF CONVERGENCE AND OBLIQUITY ANGLES

INTRODUCTION

The perception of depth in viewing photographic stereo pairs is often crucially important for making valid interpretations of photographic images. It is known that, within limits, the depth effect experienced by the observer increases as the convergence angle of the camera increases; i.e., as the lateral disparity of the two views of the same object increases. But it is not known how the experience of depth is related to the size of the camera convergence angle or whether the relation is the same for different angles of obliquity--the angle the camera makes with the vertical.

The purpose of this study was to determine, at several angles of obliquity, the relation between the size of the convergence angle and judgment of relative depth.

METHOD

Subjects. The subjects were 10 professional photointerpreters and ranged in experience from 2.5 years to 15 years with a median of approximately 4 years.

Photographs and Viewing Equipment. The photographs were of a scale model which contained a freeway, a freeway overpass, buildings of different heights and shapes, vehicles, foliage, and various terrain features.

The model was photographed at five convergence angles—10°, 15°, 20°, 25°, and 30°—at each of three obliquity angles—0°, 30°, and 60°, making a total of 15 stereo pairs. In addition to the stereo pairs, a non-stereo pair was prepared at each obliquity angle, making a total of six pairs of photographs at each obliquity angle. The non-stereo pairs were unrealistic in that the sun azimuth was not the same in each half.

The model was illuminated with lights to simulate the sun and the diffuse lighting created by atmosphere. The "sun" azimuth, "sun" elevation (60°), and modulation transfer function were the same for all experimental conditions.

Each photograph was mounted between glass slides. The pairs of photographs were viewed with a [redacted] stereo-zoom STAT microscope at a magnification set by each photointerpreter.

Procedure. Each photointerpreter made 15 comparisons among six pairs of photographs (5 stereo pairs and 1 non-stereo pair) at each obliquity angle or a total of 45 comparisons.

To control for possible order effects, the 45 pairs to be compared were presented to each photointerpreter in a different random order.

The photointerpreter's task was to answer the question, "Which of the two stereo pairs has the greater relief?"

RESULTS

A pair comparison scaling technique* was used to scale convergence angle. Only the comparisons of the stereo pairs (10 comparisons at each obliquity angle) were used to accomplish the scaling.

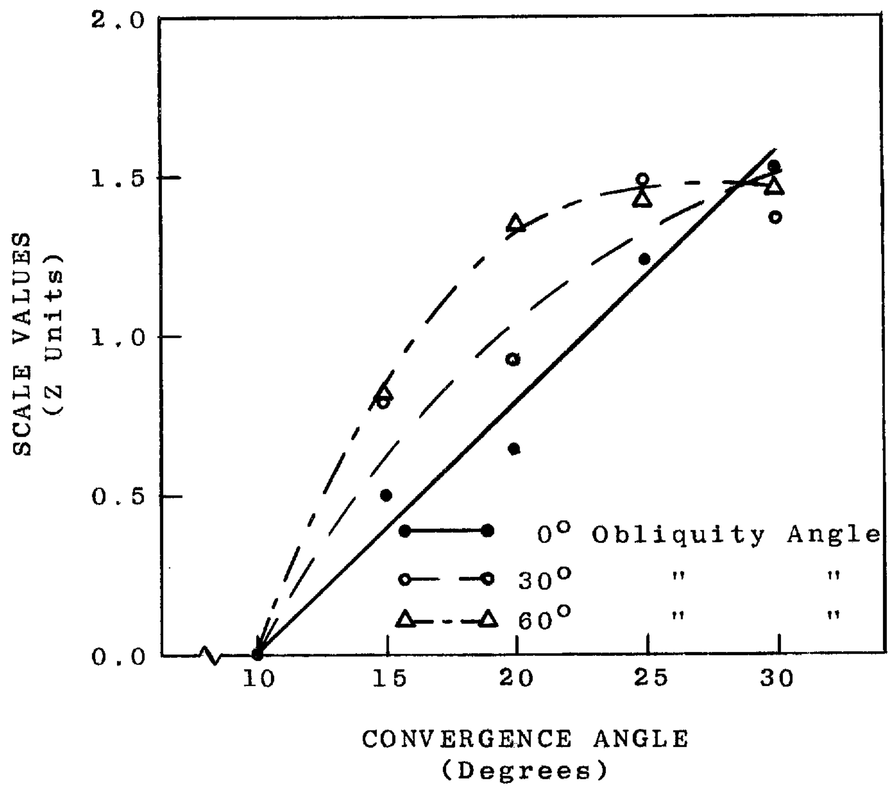
The proportion of times each stereo-pair was judged as having more depth than another pair was computed. These proportions were transformed to Z scores. (Z's are values of deviates corresponding to areas under the normal curve.) The use of this transformation

*In J. P. Guilford, 2nd ed., Psychometric Methods. New York: McGraw-Hill, 1959, Ch. 7, p. 160.

Approved For Release 2004/11/30 : CIA-RDP78B04770A000700040099-4

is based on the assumption that Z values are on a linear psychological scale.

Because the pair-comparison scaling technique does not locate a psychologically meaningful zero point, the origin of each function was set arbitrarily at 0.0 on the ordinate. Consequently only the slopes, but not the heights, of the functions may be compared.



Scale values of convergence angles at each of three angles of obliquity. The functions were fitted visually to the data point.

The results show that at each obliquity angle the scale value (amount of depth seen) increases as the convergence angle increases. At 0° obliquity, the relation between convergence angle and scale value is linear—equal differences in convergence angle produce equal differences in the amount of depth seen. But at 30° and 60° angles of obliquity, the relation is curvilinear and the curvilinearity is greater at a 60° than at a 30° angle. At these two obliquities, equal differences in convergence angle did not produce equal differences in the amount of depth seen. For example, at a 60° angle of obliquity, a change in convergence angle from 10° to 20° produces a change of about 1.30 scale units, but a change in convergence angle from 20° to 30° produces a change of only about 0.15 scale units—a much smaller change in the amount of depth seen.

Only a small sample of subjects was used in the present study; consequently the functions shown in the figure are not precise. However, the results do seem to indicate that as the angle of obliquity is increased from 0° to 60°, the relation between convergence angle and the amount of depth seen becomes increasingly curvilinear.

Inspection of the judgments made by individual photointerpreters revealed a rather unexpected finding: two of the photointerpreters were apparently unable to see differences in depth. Of the 30 comparisons of the stereo pairs, one photointerpreter made 15 correct judgments and another made 13 correct judgments; chance performance was 15 correct judgments. (A judgment was counted as an error when the stereo pair produced with a smaller convergence angle was judged as having more depth than the one produced with a larger convergence angle.) In addition, of the 15 comparisons of the non-stereo pairs with the stereo pairs, the same two photointerpreters made four and three errors respectively. That is, they judged the non-stereo pairs as having more depth than the stereo pairs. This was particularly surprising since the two halves of the non-stereo pairs did not have the same sun azimuth.